ON DEVELOPMENT OF A FRAMEWORK FOR A MOBILE BASED INTELLIGENT TUTORING SYSTEM

A synopsis

submitted in partial fulfilment

of the requirements for the degree of

Doctor of Philosophy

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2019

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1. INTRODUCTION

1.1. Educational Technology

The term **e-Learning** means to utilize electronic technologies to facilitate the task of learning, or to access educational curriculum outside of a traditional classroom. E-Learning is a very diverse domain, ranging from many different methods and mediums of education delivery to a hugely diverse scenario of use cases.

The application of educational theoretic with the help of both physical hardware and software, to provide tutoring in a meaningful manner, comes under the umbrella of Educational Technology. The definition begins with the proposition that "educational technology is the study and ethical practice of facilitating learning ..." indicating that helping people to learn is the primary and essential purpose of educational technology (Robinson et al. 2013).

E-learning is not limited to a course delivered by a DVD or a television channel. Modern e-learning starts with being interactive, and a lot of communication with the student happens throughout the learning process. With the help of artificial intelligence, the communication might just be between the student and the intelligent machine, without frequent interventions from a human tutor. This increases the pace of providing learning, but the learner still needs to take time out of their schedule to be with the machine, and if the machine is portable, this task becomes easier. We are talking about the field of mobile learning, and there is a lot of useful work that could be done in this field. We are going to move e-Learning forward by working on a specific aspect of it, which goes in the direction of mobile-based intelligent tutoring, elaborated in further sections.

1.2. Mobile Based Learning

As the numbers of handheld device users are increasing day by day, there is an opportunity to use these mobile devices to provide education to users, at their convenient time and pace.

Mobile-based learning is often termed as “m-Learning”, and it’s a new channel to access learning content using mobile phones and other similar “mobile” devices.

m-Learning is "learning across multiple contexts, through social and content interactions, using personal electronic devices"(Crompton 2013). A user of m-Learning typically uses mobile device technology to learn at their convenience.

The term “formal learning” refers to education delivered by trained teachers in a systematic way within an institute. Any type of learning which is not considered “formal learning” has its own domain called Informal Learning. Mobile-based learning includes learning from tablets, notebooks, handheld computers, which include today’s smartphones, and even learning from mp3 players. We can “use the network and mobile technology to bridge formal and informal learning” (Guglielmo and Manuela 2013).

M-Learning has a strength that it can be accessed virtually anywhere. Sharing is almost instantaneous among everyone, which leads to more responsiveness, and the instant reception of feedback and tips. This highly active process has proven to increase exam scores from the fiftieth to the seventieth percentile and cut the dropout rate in technical fields by 22 percent (Bukharaev and Altaher 2017). Some key benefits of m-Learning over other e-Learning methods include being relatively inexpensive because the cost of mobile devices is relatively less than personal computers and laptops.

1.3. Intelligent Tutoring Systems

An **Intelligent Tutoring System** (ITS) is a tutoring system which utilizes Artificial Intelligence techniques to facilitate learning (Nwana 1990). It is a computer-based system which aims to provide customized tutoring to learners, generally without requiring the regular intervention of a human teacher. These systems utilize a whole host of computing technologies for enabling learning in a meaningful and effective way. There are many examples of various different types of intelligent tutoring systems used in diverse settings in which they have demonstrated their strengths and limitations.

An Intelligent Tutoring System typically aims to replicate the demonstrated benefits of one-to-one personalized tutoring, in places where students would otherwise have access to one-to-many instruction from a single teacher (e.g., classroom environment), or no teacher at all

(e.g., online homework). Intelligent Tutoring Systems are often designed with the goal of providing access to high-quality education to each and every student, specific to the student.

Most intelligent tutoring systems need to have a populated question bank and associated topics before the system is operational. But our approach creates an intelligent tutoring system which is intelligent on both the front-end (the learner's end) and the back-end (the teacher's end). In the front-end, the system asks questions in an adaptive way, but in the back-end, the system tries to fulfil the gaps in its own knowledge base with the help of the knowledge domain expert. Every time a question is added, the system checks whether it has enough knowledge to support the question, if not, the system produces appropriate prompts at the back-end, to the knowledge domain expert until a necessary number of questions have been added and the necessary number of topics related to the domain have been populated. This results in a system which tends to complete itself whenever it feels the need to.

1.3.1. Structure of an Intelligent Tutoring System

An Intelligent Tutoring System could utilize any structure as long as it fulfils the goal of intelligent and effective tutoring. However, the earliest recollections of the proposed structure of an Intelligent Tutoring System (Freedman, Ali, and McRoy 2000; Nkambou, Mizoguchi, and Bourdeau 2010; Nwana 1990) state its structure consisting of the following four components:

- The Curriculum (domain) model
- The Student model
- The Tutor (pedagogical) model
- The Interface model

1.4. Mobile Based Intelligent Tutoring System

The strength of a mobile intelligent tutor is in delivering teaching that consists of shorter, yet more frequent learning sessions. Achieving shorter goals like correctly answering questions related to a relatively small sub-topic gives the user a sense of achievement, and smaller achievements progress towards the achievement of a comparatively larger goal. Using a

tutoring system on a desktop computer requires more dedicated time than that compared to the usage on a mobile device (Chae and Kim 2004).

It is intended to be designed for enabling the learner to learn at their own pace. One can pull up the system anywhere and continue with the learning journey. Intelligent tutoring systems are software that supports students individually, just like a real tutor. In a classroom, the communication is often one-to-many and the timeshare of each student is limited whereas in intelligent tutoring systems we don't have these limitations.

The proposed framework aims to build software which teaches a topic by selecting and posing problems specific to the students' needs. It is a framework for designing a "self-preparation" app, for learning at home, or any desired place, and learning at any desired pace. Asks the user questions regarding a topic, and based on their answers, tries to figure out which parts of the topic the user does not understand and shows those topics for the user to read. It is not merely a quiz, the assessment is done behind the scenes to teach the user in a better way, not just to show some score.

2. REVIEW OF LITERATURE

Intelligent Tutoring Systems have been around since the 1970s. The first-ever reported Intelligent Tutor developed was **SCHOLAR** (Carbonell 1970). It was developed in 1970. With time and innovations in computer technology, Intelligent Tutoring Systems have become relatively easier to develop and deploy, and due to the advances in Artificial Intelligence, they have become more accurate at providing effective tutoring.

Within education, there are plenty "domain-specific" Intelligent Tutoring Systems including but not limited to:

VanLehn et al. (2002) have developed **Why2-Atlas**, an Intelligent Tutoring System which interprets and makes analysis of students' explanations of physics principles, from the student submitted paragraph. The system transforms the words into a proof taking student's beliefs as assumptions. The system then directs the students to correct their essay, and the process is completed after a number of iterations.

In (Mitrovic 2003), the researcher has designed **SQL-Tutor**, a constraint-based tutor developed by the Intelligent Computer Tutoring Group (ICTG) at the University of Canterbury, New Zealand. It teaches students how to retrieve data from databases using SQL statements.

Researchers in (Eliot and Woolf 1994) have developed **Cardiac Tutor**, an Intelligent Tutoring System for tutoring cardiac support techniques to medical students. The system offers cardiac problems and the learner is tutored through simulation-based techniques. Verbal advice, feedback and clues are provided by the system to assist the learning.

Melis and Siekmann (2004) propose **ActiveMath**, a web-based environment for adaptive learning of Mathematics. This system aims at supporting lifelong learning. The intent is to improve the task of distance learning, for assisting in classroom teaching and for supporting individual learning.

In (Heffernan et al. 2006), the researcher has developed **REALP**, a system for enhancing the "reading comprehension" skill of the students by providing student-specific feedback and customized lexical practice, along with useful reading materials collected from the web. The proposed system attempts to model student's performance. The student is tested through exercises based around the vocabulary found in reading.

Keleş et al. (2009) describe **ZOSMAT**, a web-based Intelligent Tutoring System designed to address all the needs of a real classroom. It can be used for learning at both outside the classroom as well as to assist the inside-classroom teaching, with the guidance of a human teacher during a formal education process.

Bringula et al. (2016) have designed **Teacher AICA**, a mobile-based Intelligent Tutoring System for helping students in learning the laws of exponents. The research work states the development and deployment of an Intelligent Tutoring System for teaching the task of computing of exponents.

Researchers in (Al Rekhawi and Abu Naser 2018) have developed a web-based intelligent tutoring system for teaching Android Applications UI Development to students and overcome the difficulties during the process. This system attempts to present automatically generated problems to the students and to adapt to the student's individual learning capability.

Al-Shawwa, Alshawwa, and Abu-Naser (2019) designed an Intelligent Tutoring System for teaching the beginner level coding in JAVA. This paper describes the design of a tutoring system specifically to mimic the effects of a one-to-one teaching experience in tutoring the introductory java programming to the students.

Having studied the related literature extensively, it has been noticed that an abundance of research and saleable artefacts exist in the areas of computer-based and computer-assisted learning. And, of late, a lot of interest has been seen in the related of area e-Learning and web-based learning systems. Further, also, a few researchers have worked on synergizing the computer-based teaching-learning materials with artificial intelligence technologies, but, the area of use of artificial intelligence tools and techniques to complement and supplement the mobile-based model of teaching-learning has largely been unexplored as yet. And, yes, this is the domain that I propose to explore as my doctoral work.

3. RESEARCH OBJECTIVES AND METHODOLOGY

3.1. Problem Statement

Since the beginning of computer technology, there has been a need of using it for providing education through the development of an Intelligent Tutoring System. However, most education software packages often require a large amount of time and resources for their configuration and even during their functioning. The primary objective of my research work is to create an adaptive mobile-based intelligent tutoring system which is easy to configure and enables the learner to learn at their own desired time, place and pace, forming the title of my

research: "***On Development of a Framework for a Mobile Based Intelligent Tutoring System.***"

3.2. Research Objectives

The overall goal of the research study has been prearranged in form of following five research objectives:

1. To study the existing intelligent tutoring systems and student profiling techniques related to intelligent tutoring systems.
2. To propose a technique for student profiling – that is, deciding the knowledge levels of the students in various topics from the answer responses given by the user.
3. To propose a technique for mapping submitted multiple-choice questions to their related subject topics.
4. To integrate the proposed techniques in the form of a framework for a mobile-based intelligent tutoring system.
5. To evaluate the effectiveness of the proposed framework.

3.3. Research Methodology

First and the foremost, the system design will be carried out, establishing the inputs, outputs and defining the relationships between the various proposed components, in order to realize a raw prototype of the proposed system. The data structures to be used for storing the questions and the topics will be established along with other data structures. Data structures will be ensured to support relationships among the components. The research will be done regarding the data populating methods. Research related to student profiling/modelling in intelligent tutoring systems will be done. Performance comparison with existing techniques will be studied. Research regarding mapping questions to topics will be performed. Further research will be performed related to mapping relationships among topics according to nearness/closeness. The entire proposed framework will be defined in detail and evaluated

based on questionnaires filled by the tutors (backend users of the system) and the students (frontend users of the system) evaluating the various factors related to the system.

4. TENTATIVE CHAPTER SCHEME OF THE THESIS

1. Introduction
2. Review of Literature
3. Research Objectives and Methodology
4. Student Profiling and Question-to-Topic Mapping
5. An Intelligent Tutoring Framework
6. Performance Evaluation and Validation
7. Conclusion

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